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The Control of Pathogens in Stored Rainwater using Direct Electrochemical Activation

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• Almost 2 billion people worldwide do not have access to safely managed drinking water services\(^1\)

• In 2019, 0.8 million people died as a result of diarrhoeal diseases, contracted from the consumption of biologically contaminated water\(^2\)

• Rainwater harvesting systems enable off-grid, or remote, communities to store freshwater throughout dry periods

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\(^1\) WHO & UNICEF. Progress on drinking water, sanitation and hygiene in households 2000-2020: Five years into the SDGs. (2021);

\(^2\) World Health Organization. Water, sanitation, hygiene and Health A Primer For Health Professionals. (2019)
Electrochemical Activation [ECA]

Water + ions + energy =ECA

ECA damages and ruptures bacterial membranes through oxidation reactions

Rapid antimicrobial kinetics:
• 2 – 10 seconds

Applications in:
• Food processing
• Healthcare settings
• Drinking water disinfection

Study Aim: To control potential waterborne pathogens using small-scale direct electrochemical activation.
Methods

Guttering

ECA TREATMENT TANK
CONTROL TANK

100L Tanks

Rainwater Overflow Pipework

Sample tap

UWE, Bristol

Map Data©2021 Google
Methods

Total electrochemical activation [ECA] time: 4 hours
• Tanks were then left covered with no activation for a further 20 and 44 hours (48 hours total).

Physicochemical parameters monitored every 30 minutes
• Conductivity and oxidation reduction potential [ORP]

Biological parameters monitored every 30 minutes
• Heterotrophic bacteria (HPC) and total coliforms
Physicochemical parameter results

**Oxidation Reduction Potential**

- **Activation Period**
- **Control ORP**
- **ECA ORP**

**Conductivity**

- **Activation Period**
- **Control Conductivity**
- **ECA Conductivity**
Biological results

Heterotrophic Bacteria (HPCs)

Activation Period

Total Coliforms

Activation Period

Heterotrophic Bacteria (HPCs)

- Control HPC
- ECA HPC

Total Coliforms

- Control Coliforms
- ECA Coliforms
Conclusions

• Stored rainwater can have a relative high biological loading

• The bacteria present in the control tank remained stable through the 48 hour trials

• After 30 mins, there were no recoverable coliforms in the ECA rainwater tank, and there was a significant reduction in HPCs (p<0.0001)

• ORP did not have an effect on the antimicrobial efficacy of direct ECA of rainwater.

• Biologically safe water was maintained throughout the 44-hour period of non-ECA
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